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BASELINE STUDY OF THE WATERSHED IN THE SILVER TUSK AREA, YUKON TERRITORY

Regional Program Report 82-18

by

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ABSTRACT

A predevelopment study was undertaken by the Environmental Protection Service of the watershed near Silver Tusk Mines Ltd. in June, 1981. Except for the mine adit water which had high concentrations of dissolved salts, water quality met drinking water criteria. The sediment metals concentrations were similar to other Yukon streams except at the mine adit where high concentrations of metals reflected those present in Silver Tusk ore. The bottom fauna results were representative of clear, unpolluted, Yukon streams. The presence of trace amounts of antimony, cadmium, copper, and mercury in the ore will have to be considered in planning minewater and mill effluent treatments when Silver Tusk Mine is developed, because concentrations of these metals will have to be kept low in effluents.

RÉSUMÉ

En juin 1981, le Service de la protection de l'environnement a effectué une étude préliminaire de la partie du bassin hydrographique où se trouve Silver Tusk Mines Ltd. Si l'on excepte l'eau de la galerie d'écoulement de la mine qui contenait une forte concentration de sels dissous, la qualité de l'eau satisfaisait aux critères de l'eau potable. Le degré de concentration des métaux dans les sédiments était similaire à celui d'autres rivières du Yukon, sauf à l'endroit de la galerie d'écoulement où le haut degré de concentration en métaux s'expliquait par celui du minerai de Silver Tusk. Les données recueillies sur la faune vivant au fond de l'eau sont typiques des cours d'eau limpides et non pollués du Yukon. Quand il s'agira de mettre la mine Silver Tusk en exploitation, la planification du traitement de l'eau provenant de la mine et des effluents provenant de l'usine devra tenir compte de la présence, à l'état de traces, d'antimoine, de cadmium, de cuivre et de mercure dans le minerai, car le degré de concentration de ces métaux dans les effluents ne devra pas dépasser un certain niveau.

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1 INTRODUCTION

A study of water quality, sediment composition and bottom fauna was conducted on June 10, 1981 by the Environmental Protection Service - Yukon Branch in the watershed near Silver Tusk. The purpose of the study was to gather baseline information on the environmental quality of streams in the vicinity of the Silver Tusk gold-silver-lead-zinc ore body which is expected to be developed as a mine.

1.1 Background

The property was originally staked in 1930 and called TINTA HILL. It has since been trenched, drilled and worked underground. Other companies have since restaked or optioned the property. These include Conwest Exploration Company Limited in 1959, Canex Aerial Exploration in 1966, Silgold Mines Limited in 1968, Coin Canyon Mines in 1969, Canex Placer Limited (the renamed original owners) in 1973, and Exeter Mines Limited (renamed to Tinta Hill Mines Limited in 1975) in late 1973. Silver Tusk Mines Limited (the present operators) optioned the property at the end of 1979 from Placer Development Limited.

By the end of the 1981 exploration season, the Silver Tusk property had adits completed measuring 400 metres and 407 metres for adits 1 and 2 respectively, as well as a combined total of 973 m of drifts and cross cuts (M.H. Lavasseur, 1982). Assays from drift faces in Adit #1 (elevation 1188 m) average 6.2 gm/tonne gold, 149.3 gm/tonne silver, 0.95% copper, 5.63% lead, and 13.22% zinc. Assays from drift faces in Adit #2 (elevation 1143 m) average 11.2 gm/tonne gold, 371.4 gm/tonne silver, 1.46% copper, 7.58% lead, and 5.99%zinc (Department of Indian Affairs and Northern Development 1981). The Silver Tusk property orebody reserves are estimated at 725,750 tonnes (800,000 tons) (M.H. Lavasseur, 1981).

At the time of this study an eight to ten person camp was set up near Adit #1 to carry out underground work in Adit #1 and to develop Adit #2.

In 1982 tentative plans are for further work on drifts within adits 1 and 2. Eventually a 230 tonne (250 ton) per day mill is proposed on site to process ore from the mine. The expected life of the proposed mine and mill is eight to ten years.

The development of the mine and mill is partly dependent on the improvement of the Freegold road which would be used for access. Improvement work on this road was started by the Yukon Territory Government in 1981 and will continue in 1982.

Silver Tusk Mines Ltd. operated under a water use authorization in 1981 of 5000 litres per day for camp and adit water use. Water was obtained from a man-made reservoir (Figure 2 - sample station 3) in 1981 but this had to be supplemented with water hauled from Unnamed Creek 1. When the mine and mill are developed a reliable and larger water supply will be required.

1.2 Mineralization Description

The Silver Tusk study area lies within the unglaciated portion of the Dawson range. The bedrock is clearly exposed only along ridge tops. Granodiorite and amphibolite hosted quartz-carbonate-sulfide veins occur in a near vertical shear zone which has a northwest orientation. The shear zone is 30 m wide and 3300 m long. The veins have well defined walls and vary from 0.5 to 3 m wide. The principal minerals in the veins are galena (PbS) and sphalerite (ZnS) with minor amounts of chalcopyrite ($CuFeS_3$), tetrahedrite (Cu(Ag)SbS) and pyrite (FeS_2). Minor amounts of chalcopyrite and pyrite are disseminated in the wall rocks. Malachite and azurite, (copper carbonate compounds) are associated with oxidized areas of the vein. Core samples show a polymetallic vein system containing high lead (Pb), zinc (Zn), copper (Cu), silver (Ag), cadmium (Cd), molybdenum (Mo), antimony (Sb), and mercury (Hg) and low manganese (Mn), arsenic (As), thallium (Tl) and boron (B). (Department of Indian Affairs and Northern Development, 1981e; Morin et al, 1977).

2 STUDY AREA

The Silver Tusk property lies approximately 40 km (25 miles) northwest of Carmacks, Yukon Territory, at the headwaters of Stoddart and Merrice Creeks on the southern slope of Granite Mountain (Figure 1). The property has easy access via an 11 km (7 mile) tote road which leaves the Freegold road at approximately 52 km (33 mile). The camp, adits and sample stations all lie within the Silver Tusk claims boundaries (Figure 2). The property lies at elevations from 3300 to 4100 ft (1000 to 1250 m).

The water bodies which would be affected by the proposed mine and mill activities are Stoddart Creek, Big Creek into which it drains and possibly Merrice Creek. All are part of the Yukon River drainage basin. Indigenous fish populations are known to exist in the Yukon River and Big Creek. Big Creek and Stoddart Creek are used for recreational fishing only.

Sampling stations were selected to include a control station which would be unaffected by Silver Tusk activity, Station 1 on Unnamed Creek 1; a station to measure minewater quality from Adit 1, Station 2; a station to measure predevelopment water quality in Unnamed Creek 2, Station 3; and a station which would measure downstream effects of Silver Tusk activity, Station 4 on Unnamed Creek 1 (see Figure 2). The sample sites are described in Table 1 and illustrated in photographs in figures 3 to 6.

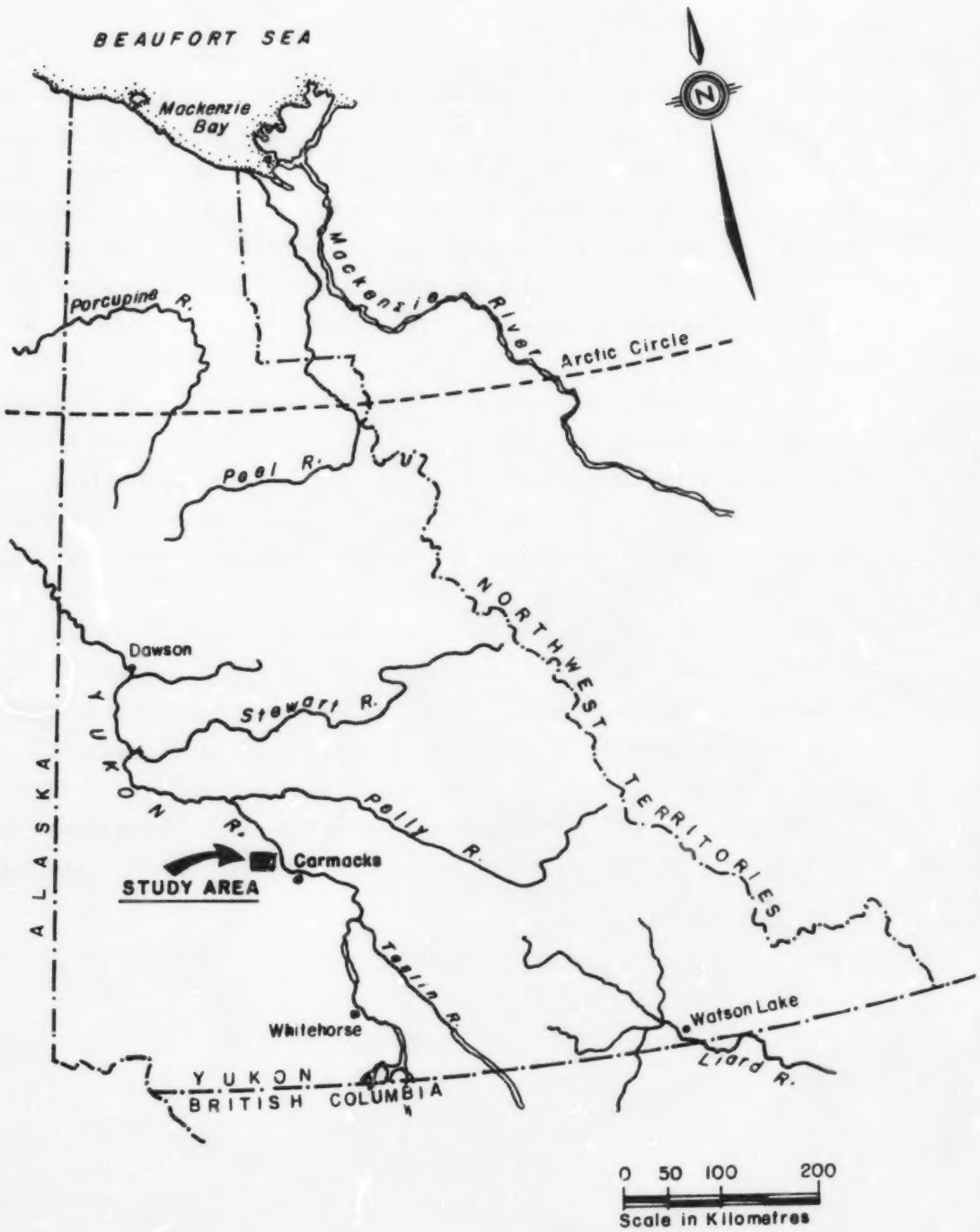

FIGURE 1 LOCATION OF SILVER TUSK STUDY AREA

FIGURE 2 SILVER TUSK STUDY AREA SHOWING CREEKS, MINERAL CLAIMS AND SAMPLE STATIONS

TABLE 1 DESCRIPTION OF SAMPLE SITES IN SILVER TUSK STUDY AREA

STATION	LOCATION	STREAM BOTTOM	REMARKS
1	62°16'N 136°59'W. Located near the head of Unnamed Creek 1, draining west into Stoddart Creek. Elevation 3700 ft (1127 m).	Coarse gravels with organic sediments found in pools. Stable banks, covered with grasses. 50% of gravel discarded from sediment sample.	No fish obtained from electrofishing. 0% shade.
2	62°17'N 136°58'W at opening of adit 1, draining run off from melting ice in adit. Water flows in direction of Station 1 and becomes subsurface within 1 km. Elevation 3900 ft (1188 m).	Medium to fine crushed gravel from blasting and drilling operations. Muskeg downstream within 0.5 km. 30% of gravel was discarded from sediment sample. Unstable stream bed near adit.	Flow frozen in winter. No fish access to this water. Not suitable for bottom fauna.
3	62°17'N 136°59'W. Camp water storage reservoir in muskeg muds. Run off is subsurface and drains towards Station 4 via intermittent Unnamed Creek 2. Elevation 3850 ft (1173 m).	Organic soil. Reservoir banks are unstable and unvegetated.	Reservoir exposes water table. No fish access to this water. Not suitable for bottom fauna.
4	62°17'N 136°59'W. Unnamed Creek 1 draining west to Stoddart Creek. Downstream of Station 1 and its confluence with Unnamed Creek 2. Elevation 3600 ft (1097 m).	Medium size rounded gravel. Banks are heavily vegetated with willow and grasses. Banks are stable. 50 - 80% of gravel was discarded from sediment sample.	No fish observed. Not suitable for electrofishing. Stream likely totally frozen in winter. 90% shaded.

FIGURE 3 SILVER TUSK SAMPLING STATION #1 ON UNNAMED CREEK 1. COARSE GRAVELS WITH ORGANIC SEDIMENTS FOUND IN POOLS. BANKS STABLE, COVERED WITH GRASSES.

FIGURE 4 SILVER TUSK SAMPLING STATION #2, ADIT #1, 1182 m (3900 ft). NOTE ICE INSIDE ADIT. FINE TO MEDIUM CRUSHED GRAVEL FORMS UNSTABLE STREAM BED NEAR ADIT.

FIGURE 5 SILVER TUSK SAMPLING STATION #3, CAMP WATER SUPPLY. DRAINS INTO UNNAMED CREEK 2. ORGANIC SOIL, RESERVOIR BANKS ARE UNSTABLE AND UNVEGETATED.

FIGURE 6 SILVER TUSK SAMPLING STATION #4 ON UNNAMED CREEK 1, DOWNSTREAM OF ITS CONFLUENCE WITH UNNAMED CREEK 2 AND DOWNSTREAM OF STATION 1 ON SAME UNNAMED CREEK. MEDIUM SIZE ROUND GRAVEL STREAM BED. BANKS ARE STABLE AND HEAVILY VEGETATED WITH WILLOW AND GRASSES.

3 METHODS

Access to Stations 1, 2 and 3 was by truck, and to Station 4 was by foot. Each station was sampled once on June 10, 1981.

3.1 Water Quality

Water samples were collected and preserved at each of the four (4) sample sites as described in Appendix I, Table 1.

Temperature, pH, conductivity and flow were measured in the field by Environmental Protection Service staff. Dissolved Oxygen (DO) was measured in the Environmental Protection Service laboratory, 122 Industrial Road, Whitehorse. All other water quality analyses were done by Laboratory Services, Environmental Protection Service, 4195 Marine Drive, West Vancouver, British Columbia. Analytical methods are described in Appendix I, Table 1.

Water samples were collected and preserved for analysis of conductivity, pH, colour, turbidity, filterable residue (FR), non-filterable residue (NFR), total alkalinity, total hardness, total phosphates, nitrite, nitrate, ammonia, sulphate, cyanide, chloride, silica, and the following extractable metals:

Aluminum (Al)	Copper (Cu)	Selenium (Se)
Antimony (Sb)	Iron (Fe)	Silver (Ag)
Arsenic (As)	Lead (Pb)	Sodium (Na)
Barium (Ba)	Magnesium (Mg)	Strontium (Sr)
Beryllium (Be)	Manganese (Mn)	Tin (Sn)
Cadmium (Cd)	Mercury (Hg)	Titanium (Ti)
Calcium (Ca)	Molybdenum (Mo)	Vanadium (V)
Chromium (Cr)	Nickel (Ni)	Zinc (Zn)
Cobalt (Co)	Potassium (K)	

The percent dissolved oxygen (% DO) saturation was calculated by first determining the dissolved oxygen saturation concentration (S') from the formula:

$$S' = S \frac{P}{760}$$ (APHA et al 1975)

where S' = Dissolved Oxygen (DO) saturation concentration at the in situ temperature and atmospheric pressure

S = Dissolved Oxygen saturation concentration at sea level for in situ temperature

P = atmospheric pressure in mm of mercury (mm Hg) at site elevation

Then percent dissolved oxygen saturation was obtained by using the ratio of field dissolved oxygen to S' in the following formula:

$$\frac{\text{Field DO}}{S'} \times 100 = \% \text{ DO Saturation}$$

where Field D.O. = Dissolved Oxygen concentration measured in the field

3.2 Sediments

Sediment samples were collected simultaneously with water samples at Stations 1, 2, 3 and 4. Four sediment samples were collected at each site, using an aluminum shovel to scoop the samples into labelled Whirl Pak bags. A description of sediment collection, preparation and analysis methods is given in Appendix I, Table 2. All sediment samples were shipped to Vancouver by air for analysis at Laboratory Services, Environmental Protection Service, 4195 Marine Drive, West Vancouver.

One sediment sample per station was analysed for cyanide concentration. The other three sediment samples were each analyzed for particle size and the following leachable metals:

Aluminum (Al)	Iron (Fe)	Selenium (Se)
Antimony (Sb)	Lead (Pb)	Silicon (Si)
Arsenic (As)	Magnesium (Mg)	Silver (Ag)
Barium (Ba)	Manganese (Mn)	Sodium (Na)
Beryllium (Be)	Mercury (Hg)	Strontium (Sr)
Cadmium (Cd)	Molybdenum (Mo)	Tin (Sn)
Calcium (Ca)	Nickel (Ni)	Titanium (Ti)
Chromium (Cr)	Phosphorus (P)	Vanadium (V)
Copper (Cu)	Potassium (K)	Zinc (Zn)

3.3 Bottom Fauna

Bottom fauna were sampled at only two of the four sampling stations. These were stations 1 and 4 which are both on Unnamed Creek 1. The other sampling stations were disturbed sites, not suitable for bottom fauna. Three samples were taken at each site on June 10, 1981, using a 30 cm x 30 cm Surber sampler (total area is 900 cm^2) with a mesh size of 0.76 mm. Bottom fauna collection, preservation and identification methods are given in Appendix I, Table 3.

Diversity indices were calculated from the bottom fauna data collected, using the formula described by Pielou (1975) as follows:

$$\text{Species Diversity } (H') = -\sum_{i=1}^{g} (P_i \log_{10} P_i)$$

where $P_i = n_i/N$

n_i = total number of individuals in the ith genus in one sample

N = total number of individuals identified to genus and/or species taxonomic level in one sample

g = total number of genera in one sample

The use of individuals identified to genus level rather than to species level results in slightly lower diversity indices (H') values (Hughes 1978).

Diversity values calculated for the two stations samples are listed in Appendix IV, Table 2.

3.4 Fish

The study objective was to collect fish by electrofishing to obtain tissue samples for metals analysis. However only Station 1 was suitable for electrofishing and no fish were obtained. Stations 2 and 3 were in disturbed areas which were inaccessible to fish. Station 4 was too shallow and too obstructed with branches for electrofishing. A Smith Root Type-VIII electrofisher was used.

4 RESULTS AND DISCUSSION

4.1 Water Quality

Silver Tusk water quality data is listed in Appendix II. Detection limits and analytical procedures for water quality are found in Appendix I, Table 1. All values were compared to the recommended levels for drinking water and aquatic life listed in Appendix I, Table 4.

With the exception of Station 2, mine adit water, all measurements at the stations were similar to those found in other unaffected creeks in the Yukon by (Mathers et al 1981) and were acceptable for drinking water. Water from Station 3 was being used for camp drinking water. Station 2, mine adit water, contained high concentrations of dissolved salts and exceeded limits for drinking water for several important parameters.

Measurements of colour, iron and manganese at Station 2; and colour at Station 4 slightly exceeded drinking water limits but these levels would not make it unsafe for drinking since colour, and iron levels are set for aesthetic reasons and the manganese level was only slightly exceeded. The detection limit for selenium (0.075) is higher than the drinking water limit (0.01) but all stations were less than detection limit.

Station 2, mine adit water, exceeded the drinking water limits for turbidity, non-filterable residue, hardness, nitrite, ammonia, cadmium, iron, manganese and lead. High turbidity and non-filterable residue were caused by activity at the mine adit. The high nitrite and ammonia concentrations are probably caused by compounds present in explosives used in mining and for removing ice from the adit opening. Iron concentrations have a high background level in this area and were present in similar concentrations at all stations. Manganese and lead concentrations reflect the presence of these metals in the ore and gangue minerals.

Other measurements that were higher at Station 2 than at the other stations in this study were conductivity, filterable residue, phosphate, nitrate, sulfate, cyanide, chloride, calcium, copper, strontium and zinc (see Appendix II). The high nitrate and cyanide concentrations probably come from explosives used in the mine adit. The high sulfate, copper, strontium, and zinc concentrations reflect the presence of sulfide ore minerals and copper, strontium and zinc in the ore. High concentrations of calcium and chloride at Station 2 were caused by the use of $CaCl_2$ to melt adit ice. Concentrations of these elements were twice as high on June 10, 1981 as they were on May 22, 1981 before $CaCl_2$ was used (Department of Indian Affairs and Northern Development unpublished data for May 22, 1981).

Some metals which were present in high amounts in ore core samples but not high in the mine adit water are antimony, mercury, molybdenum and silver. They must be less soluble in groundwater. One metal which was low in ore core samples but high in mine adit water was manganese.

Only Station 1 and 4 parameters were assessed for aquatic habitat suitability because Station 2, mine adit water, and Station 3, drinking water reservoir, were disturbed sites unsuitable for aquatic life. Aquatic life limits (see Appendix I, Table 4) were not exceeded at Station 4. They were exceeded for aluminum at Station 1 and conductivity was too low at Station 1 to support healthy aquatic life populations. It could not be determined if aquatic life limits were exceeded at Stations 1 and 4 for the following parameters because detection limits exceeded aquatic life limits: cyanide, arsenic, cadmium, nickel, selenium and silver. However, concentrations at these stations were all below detection limit. Stations 1 and 4 water quality parameters indicate that they should support aquatic life but possibly in reduced numbers.

4.2 Sediments

4.2.1 Sediment Metal Concentrations. Concentrations of antimony (Sb), cadmium (Cd), copper (Cu), lead (Pb), mercury (Hg), silver (Ag) and zinc (Zn) from Station 2, the mine adit, reflect their presence in the Silver Tusk ore body (see Appendix III, Table 1). The remaining stations have concentrations of these metals near or below their detection limits and similar to other Yukon streams (Mathers et al 1981). For a comparison, Silver Tusk stations low concentration versus Station 2 high concentrations are as follows: <0.795 versus 3.46 mg/kg Sb, <0.56 versus 21.4 mg/kg Cd, 10.3 versus 244 mg/kg Cu, <6.62 versus 1340 mg/kg Pb, 0.155 versus .375 mg/kg Hg, <4.84 versus 6.94 mg/kg Ag, and 66.7 versus 2590 mg/kg Zn.

Calcium readings in the sediments of the adit are in the neighbourhood of six times the levels found in other Yukon streams (Mathers et al 1981).

Barium (Ba) levels in other Yukon streams (Mathers et al 1981) averaged approximately 160 mg/kg. The barium (Ba) readings at all sample stations in the Silver Tusk study area exceeded this average by two to seven times.

The iron (Fe) level in sediments at Station 3, the camp drinking water, were higher than other station readings and the only iron (Fe) reading in the study area to exceed levels of other Yukon streams (Mathers et al 1981).

The tin (Sn) level in sediments at Stations 3 and 4 was higher than that found in other Yukon streams. The titanium (Ti) level in sediments at Station 3 was about double that found in other Yukon streams.

Concentrations of all other elements tested were similar to those found in other Yukon streams as reported in Mathers et al, 1981.

4.2.2 Sediment Particle Size Analysis. The results of the sediment particle size analysis are given in Appendix III, Table 2.

Station 2 , the opening of the mine adit, has a high percent of sediment that passes through a sieve with a 149 um mesh. Thirty-eight percent of the sediment sample at Station 2 was able to pass through this 149 um mesh, in comparison to Station 1 where it only constitutes 13%, Station 3 - 17% and Station 4 - 4%. Only the portion smaller than 149 um were analysed for metals in this study.

By mentally correlating the concentration of metals and the portion of the sediment composition it approximately represents, it can be seen that a high concentration and a large portion smaller than 149 um would have a large effect on the aquatic environment. At Silver Tusk, none of the stations that are used by aquatic life have this combination.

4.3 Bottom Fauna

A summary of Silver Tusk bottom fauna numbers and diversity indices is given in Table 2. Stations 1 and 4, both on Unnamed Creek 1, were the only stations where bottom fauna were successfully collected. The remaining stations, Stations 2 and 3, were both disturbed areas not suitable for bottom fauna. Appendix IV, Table 1 lists the bottom fauna taxonomic groups found in the Silver Tusk watershed, listed in the order found in "Fresh-Water Invertebrates of the United States", R. Pennak. Appendix IV, Table 2 lists the number of individuals in each taxonomic group in each sample and the diversity index for that sample.

TABLE 2 SUMMARY OF SILVER TUSK BOTTOM FAUNA DIVERSITY INDICES AND NUMBERS

STATION NUMBER	DIVERSITY (H')	NUMBER PER FT^2	CALCULATED NUMBER PER M^2
1-1	0.86	31	334
1-2	0.59	22	237
1-3	0.82	39	420
4-1	0.63	242	2604
4-2	0.58	68	732
4-3	0.61	45	484

The diversity index is a measure of community structure and relative stability. Communities of high diversity are characterized by large numbers of species with no single species overwhelmingly abundant. Communities of low diversity contain few species, some of which are represented in disproportionately high numbers. High diversity is characteristic of relatively undisturbed, unpolluted waters. Low diversity is often associated with disturbed, stressed, unstable or polluted waters.

The diversity indices found in the Silver Tusk study area were similar to those found in the Howard's Pass area of the Yukon (Archibald et al 1981). They ranged from 0.61 to 0.86 at Silver Tusk as compared to 0.52 to 0.92 at Howard's Pass. The number of individuals per ft^2 were lower at Station 1 than at Station 4 but both were similar to those found in the Howard's Pass area. The differences in numbers between the two stations is probably the result of their local environments. The water level probably stays more constant at Station 4, the downstream site, and water conductivity was more favourable for aquatic life at Station 4. However Station 4 was 90% shaded while Station 1 was not shaded. Shading usually reduces the number of bottom fauna in the Yukon.

Individuals from order Plecoptera and order Diptera, family Chironimidae were present at both stations. Order Ephemeroptera was only represented at Station 1. Genus Podmosta of order Plecoptera and genus Heterotrissocladius of order Diptera, family Chironimidae were present in the largest numbers and at both stations.

The total number of taxa collected in the Silver Tusk area was 29 which was much lower than the 54 taxa collected in the Howard's Pass area but this is partly a result of the much more intensive sampling at Howards Pass; 7 stations versus the 2 stations at Silver Tusk.

In summary, the bottom fauna collected in the Silver Tusk area were similar in numbers, taxonomic groups and diversity indices to those found in other areas of the Yukon.

4.4 Fish

The objective of fish collection in this study area was to obtain fish tissue samples for metal analysis rather than to assess abundance or diversity of fish.

In the Silver Tusk study area, attempts to collect fish were made using an electrofisher. Station 1 on unnamed creek 1 was the only sample station that was suitable for electrofishing. Results were negative.

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APPENDICES

APPENDIX I

COLLECTION, PRESERVATION, ANALYSIS OR IDENTIFICATION METHODS AND WATER QUALITY CRITERIA

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE[1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Temperature		In situ temperature reading.	Standard Centigrade Thermometer	
Flow		Flow measurements taken for general evaluation purposes only.	Cross-section of stream was estimated and the velocity of flow was measured by noting the time it took a twig to travel a given length of the stream, i.e., 5 m. Flow measurement given in m^3/s.	
Dissolved Oxygen	1.00 mg/l	Duplicate samples collected in 300 ml glass BOD bottles. The BOD bottles were rinsed 3 times with sample before filling. Preserved with 2 ml manganese sulphate and 2 ml alkali-iodide-azide solution and shaken 15 times. A water seal was maintained and DO analysis was done within 7 days.	Iodometric Azide Modification Winkler Titration Method	048
pH		Small aliquots of sample were taken and read soon after collection. No preservative.	Potentiometric	080
Conductivity	0.2 umhos/cm	In situ measurement. Laboratory measurement. No preservative. The measurement was taken from the same as NH_3 below.	YSI Conductivity Meter Model 33 Radiometer Conductivity Meter (CDMC) with radiometer conductivity cell.	044

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE[1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Ammonia NH_3-N	0.0050 mg/l	Single samples collected in 2 litre linear polyethylene containers. The container was rinsed 3 times with sample before it was filled. No preservatives. Stored at 4°C.	Phenol Hypochlorite-Colorimetric-Automated	058
Colour	5 (colour units)	Same sample as NH_3.	Platinum-Cobalt Visual Comparison	040
Turbidity	1.0 (FTU)	Same sample as NH_3.	Nephelometric Turbidity	130
Non-Filterable Residue (NFR)	5.0 mg/l	Same sample as NH_3.	Filtration, drying and weighing of residue on filter	104
Filterable Residue (FR)	10.0 mg/l	Same sample as NH_3.	Filtration, drying and weighing of filtrate	100
Total Alkalinity	1.0 mg/l as $CaCO_3$	Same sample as NH_3.	Potentiometric Titration	006
Total Phosphate T PO_4-P	0.0050 mg/l	Same sample as NH_3.	Acid-persulphate, Autoclave Digestion	086
Nitrite NO_2-N	0.0050 mg/l	Same sample as NH_3.	Diazotization-Colorimetric-Automated	070
Nitrate NO_3-N	0.010 mg/l	Same sample as NH_3.	Cadmium Copper Reduction Colorimetric Automated	072

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE[1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Sulphate SO_4	1.00 mg/l	Same sample as NH_3.	Barium Chloranilate -UV Spectrophotometric	122
Chloride Cl	0.50 mg/l	Same sample as NH_3.	Thiocyanate-Combined Reagent-Colorimetric	024
Cyanide CN	0.03 mg/l	Sample was collected in a 1 litre nalgene wide mouth bottle, which was rinsed 3 times with sample before filling. The sample was preserved with NaOH pellets to pH >12 and stored at 4°C.	Tetracyanonickelate (II) - UV - Colorimetric	032
Silica Total Si	0.50 mg/l	Same sample as NH_3.	Ascorbic Acid Reduction - Colorimetric	118
Mercury Total Hg	0.00020 mg/l	Single samples were collected in a 200 ml linear polyethylene bottle. Preserved with 10 ml 5% nitric dichromate solution.	Open Flameless System for Hg-AAS Determination	211 224 284 411
Extractable Metals	mg/l	Single samples collected in 200 ml linear polyethylene bottles. The bottle was rinsed 3 times with sample before filling. Preserved to a pH <1.5 using 2.0 ml concentrated HNO_3.	Inductively Coupled Argon Plasma (ICAP) combined with Optical Emission Spectrometer (OES)	210 592
Al	0.050			
As	0.075			
Ba	0.0015			
Be	0.0010			
Ca	0.050			
Cd	0.0040			
Co	0.0075			

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE[1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Extractable metals (con't)	mg/l			
Cr	0.0075			
Cu	0.0050			
Fe	0.0050			
Mg	0.10			
Mn	0.0010			
Mo	0.015			
Na	0.050			
Ni	0.040			
Pb	0.040			
Sb	0.040			
Se	0.075			
Sn	0.10			
Sr	0.0020			
Tl	0.0040			
V	0.020			
Zn	0.0050			
Cd	0.0010	Same sample as metals.	Graphite Atomic Absorption Flameless Technique (AAS)	Atomic Absorption Jarrel-Ash 850 Manual
Cu	0.0010	Same sample as metals.		
Pb	0.0010	Same sample as metals.		
Zn	0.0010	Same sample as metals.		
Ag	0.030	Same sample as metals.	Flame Atomic Absorption Spectrophotometry	210 290

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE[1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
K	0.010 mg/l	Same sample as metals.	Flame Atomic Emission Spectrophotometry	210 423
Total Hardness	0.030 mg/l as $CaCO_3$	Same sample as metals.	The sum of the ICAP results for Mg x 4.116 and Ca x 2.497 reported as mg/l $CaCO_3$	

1 As described in Environment Canada (1976).

2 As described in Department of Environment (1979).

APPENDIX I- TABLE 2 SEDIMENT COLLECTION, PREPARATION AND ANALYSIS METHODS

PARAMETER	COLLECTION/PREPARATION	ANALYSIS	METHOD CODE[1]
All Parameters	Creek Stations: Sediment samples were collected using an aluminum shovel to scoop sample into pre-labelled Whirl-Pak bags. Four samples were taken at each station. Samples were kept cool and were frozen (-19°C) as soon as possible.		
Cyanide CN	Some distilled water was added to a known weight of sediment sample before starting the digestion step in the analytical procedure.	Tetracyanonickelate (II) - UV - Colorimetric Method	032
Mercury Hg (Total)	Sample was freeze-dried for 48 hours to remove water. Sample was sieved through a size 100 mesh (.15 mm) stainless steel sieve. The portion passing through was analyzed for mercury. Sample was completely oxidized by digestion with H_2SO_4 and H_2O_2.	Atomic Absorption Spectrophotometer - Open Flameless System	231 236 238 275 284 411
Metals (Leachable) Al Ba Be Ca Cd Cr Cu	Same as Mercury except portion passing through was analyzed for metals. Sample was leached with HCl and HNO_3. The sample was heated for 3 hours.	Inductively Coupled Argon Plasma (ICAP) Combined with Optical Emission Spectrometer (OES)	231 236 238 242

APPENDIX I TABLE 2 SEDIMENT COLLECTION, PREPARATION AND ANALYSIS METHODS (continued)

PARAMETER	PREPARATION	ANALYSIS	METHOD CODE[1]
Metals (Leachable) (continued)			
Fe			
Mg			
Mn			
Mo			
Na			
Ni			
P			
Pb			
Si			
Sn			
Sr			
Ti			
V			
Zn			
As	Same as other metals.	Hydride Generation ICAP	J. Davidson
[2]Sb	Same as other metals.	Hydride Generation ICAP	EPS Lab
[2]Se	Same as other metals.	Hydride Generation ICAP	
Ag	Same as other metals.	Flame Atomic Absorption Spectrophotometry	290
Cd	Same as other metals.	Graphite Flameless Atomic Absorption	Jerrel-Ash 850 Manual
K	Same as other metals.	Flame Atomic Emission Spectrophotometry	423
Particle Size	Sample was freeze-dried.	Standard Sieving Operation	078

1 Department of Environment, Department of Fisheries and Oceans, Laboratory Manual, Environmental Protection Service, Fisheries and Marine Service (1979).

2 The concentrations of Sb and Se are for information only since the analysis method has not yet been fully tested.

APPENDIX I TABLE 3 BOTTOM FAUNA COLLECTION, PRESERVATION AND IDENTIFICATION METHODS

FIELD COLLECTION, SAMPLING PROCEDURES AND PRESERVATION	LABORATORY PROCEDURES	IDENTIFICATION AND ENUMERATION
Surber Sampler: Creek and river samples were taken using a Surber Sampler with a 60 cm long net (mesh size 0.76 mm). Area sampled was 900 cm^2 (1 ft^2). Surber samples were washed into a cup at the bottom of a plankton net (.75 mm mesh size), put in separate labelled glass jars and preserved with 10% formalin. 3 samples were taken at each station.	Bottom fauna was removed from other material in a labelled vial containing 70% methanol.	Bottom fauna was sent to Dr. C. Low, Consulting Invertebrate Biologist, Nanaimo, B. C. for identification to genus, species if possible, and enumeration.

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE
Physical				
Colour Pt. Counts	15	1		
Odour and taste	0	1		
Turbidity J.T.U.	5	1		
Chemical				
Alkalinity mg/l (Total)	Not considered a public health problem	4	>20	3
Aluminum (Al) mg/l	Not considered a public health problem	7	0.1	5
Ammonia (NH_3-N) mg/l	0.5	4	0.02	3
Antimony (Sb) mg/l				
Arsenic (As) mg/l	0.05	1	0.05	2
Barium (Ba) mg/l	1.0	1	5.0	7
Boron (Bo) mg/l	1.0	1		
Cadmium (Cd) mg/l	0.005	1	0.0002	2
Calcium (Ca) mg/l	75-200	7		
Chloride (Cl)mg/l	250	1		
Chromium (Cr) mg/l	0.05	1	0.04	2
Cobalt (Co) mg/l				
Conductivity @ 25°C (umhos/cm)	Depends on dissolved salts	7	150-500	6
Copper (Cu) mg/l	1.0	1	0.005	5
Cyanide (CN) mg/l	0.2	1	0.005	3
Dissolved oxygen (% saturation)	Near 100%	4	$\geq$5.0 mg/l	3

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE (continued)

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE
Fluoride (F) mg/l	1.5	1	1.5	7
Hardness (Total) as mg/l $CaCO_3$	80-100	1		
Iron (Fe) mg/l	0.3	1	1.0	3
Lead (Pb) mg/l	0.05	1	0.005 (soft H_2O*)	2
			0.01 (hard H_2O*)	2
Magnesium (Mg) mg/l	50	4		
Manganese (Mn) mg/l	0.05	1	1.0	7
Mercury (Hg) mg/l	0.002	1	0.0001-0.0002	2
Molybdenum (Mo)				
Nickel (Ni) mg/l	0.25	2	0.025 (soft H_2O*)	2
			0.25 (hard H_2O*)	2
Nitrate (NO_3-N) mg/l	10	1		
Nitrite (NO_2-N) mg/l	0.001	1		
pH units	6.5 - 8.5	1	6.5 - 9.0	3
Phosphorus (P) mg/l (Total)			0.020 to prevent algae	5
Potassium (K) mg/l				
Residue: Filterable mg/l (Total dissolved solids)	1000	4	70 - 400 with a maximum of 2000	6
Residue: Non-Filterable (mg/)				
Selenium (Se) mg/l	0.01	1	0.01	2
Silica (Si) mg/l				
Silver (Ag) mg/l	0.05	1	0.0001	2
Sodium (Na) mg/l	20	1		
Strontium (Sr) mg/l	10	1		
Sulphate (SO_4) mg/l	500	1		
Tin (Sn) mg/l	Not present in natural waters	7		
Titanium (Ti) mg/l				

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE (continued)

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE
Total Inorganic Carbon (TIC)				
Total Organic Carbon (TOC)	5.0	5		
Vanadium (V)				
Zinc (Zn) mg/l	5.0	1	0.030	5

* Soft water has a total hardness less than 95 mg/l as $CaCO_3$. Hard water has a total hardness of more than 95 mg/l as $CaCO_3$ (Reference 6).

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2. Inland Waters Directorate, Guidelines for Surface Water Quality, Vol. 1, Inorganic Chemical Substances. Environment Canada, Ottawa (1979, 1980).

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4. Anonymous, Guidelines for Establishing Water Quality Objectives for the Territorial Waters of the Yukon and Northwest Territories. Report of the Working Group on Water Quality Objectives to the Chairmen, Water Boards, Yukon and Northwest Territories, July (1977).

5. Ontario Ministry of the Environment, Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment. (1978).

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE (continued)

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE

6. Environment Canada, Pollution Sampling Handbook. Pacific Region Laboratory Services, Fisheries Operations and Environmental Protection Service, West Vancouver, B.C. (1976).

7. California State Water Resources Control Board, Water Quality Criteria. Publication No. 3-A Second Edition by McKee and Wolf. (1963).

APPENDIX II

WATER QUALITY DATA

APPENDIX II SILVER TUSK WATER QUALITY DATA - JUNE 10, 1981

STATION NUMBER	FLOW m^3/s	TEMP (°C)	D.O. (mg/l)	% D.O. SATURATION (%)	IN SITU pH	LAB pH	IN SITU CONDUCTIVITY (umhos/cm)	LAB CONDUCTIVITY (umhos/cm)	COLOUR (colour units)	TURBIDITY (FTU)
1	<0.010(e)	4.0	7.35	64	-	7.0	24	40.1	90	2.7
2	<0.010(e)	4.8	8.37	75	-	7.6	750	1125	10	11.0
3	<0.010(e)	14.0	7.55	84	-	7.4	70	96.0	40	12.0
4	0.012(e)	2.0	8.20	68	-	7.6	99	192.0	25	<1.0

(e) Very rough estimate

STATION NUMBER	N.F. RESIDUE (mg/l)	F. RESIDUE (mg/l)	TOTAL ALKALINITY (mg/l as $CaCO_3$)	TOTAL HARDNESS (mg/l as $CaCO_3$)	TOTAL PO_4-P (mg/l)	NO_2-N (mg/l)	NO_3-N (mg/l)	NH_3-N (mg/l)	SO_4 (mg/l)	CN (mg/l)	Cl (mg/l)
1	<5	72	23.8	18.3	0.0074	<0.0050	0.008	0.0145	3.90	<0.03	0.90
2	146	913	186	530	0.235	0.569	3.71	1.93	344	0.03	3.27
3	31	87	44.0	40.8	0.0505	<0.0050	0.036	0.0188	5.20	<0.03	0.77
4	<5	142	82.0	88.5	<0.0050	<0.0050	0.075	0.0083	17.1	<0.03	0.60

APPENDIX II SILVER TUSK WATER QUALITY DATA - JUNE 10, 1981 (continued)

STATION NUMBER	Ag mg/l	Al mg/l	As mg/l	Ba mg/l	Be mg/l	Ca mg/l	Cd mg/l	Co mg/l	Cr mg/l	Cu mg/l	Fe mg/l	Hg mg/l	K mg/l
1	<0.030	0.241	<0.075	0.0412	<0.0010	5.43	<0.0010	<0.0075	<0.0075	0.0024	0.766	<0.00020	0.324
2	<0.030	0.421	<0.075	0.0847	<0.0010	170	0.0131	<0.0075	<0.0075	0.0122	0.656	<0.00020	1.77
3	<0.030	0.316	<0.075	0.0561	<0.0010	13.0	<0.0010	<0.0075	<0.0075	0.0016	0.695	<0.00020	0.231
4	<0.030	0.080	<0.075	0.129	<0.0010	26.2	<0.0010	<0.0075	<0.0075	0.0011	0.124	<0.00020	0.439

STATION NUMBER	Mg mg/l	Mn mg/l	Mo mg/l	Na mg/l	Ni mg/l	Pb mg/l	Sb mg/l	Se mg/l	Si mg/l	Sn mg/l	Sr mg/l	Ti mg/l	V mg/l	Zn mg/l
1	1.14	0.0568	<0.015	1.58	<0.040	0.0018	<0.040	<0.075	4.99	<0.10	0.0493	<0.0040	<0.020	0.0059
2	25.6	0.294	<0.015	10.1	<0.040	0.101	<0.040	<0.075	4.48	<0.10	2.20	0.0066	<0.020	0.948
3	2.03	0.0461	<0.015	3.00	<0.040	<0.0010	<0.040	<0.075	5.93	<0.10	0.119	0.0073	<0.020	0.0052
4	5.60	0.0187	<0.015	3.81	<0.040	<0.0010	<0.040	<0.075	5.66	<0.10	0.604	<0.0040	<0.020	0.0032

APPENDIX III

SEDIMENT DATA

APPENDIX III TABLE 1 SILVER TUSK SEDIMENT CHEMISTRY DATA, JUNE 10, 1981
(all concentrations given in mg/kg dry weight unless otherwise noted)

STATION	Wet/Dry Ratio	CN w/w*	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg
1-1	1.13	<0.13	<4.84	19300	4.83	711.0	0.492	5830	<0.58	24.2	14.8	30800	0.172	1960	4180
1-2			<4.87	18200	5.12	896.0	0.503	4860	<0.58	22.7	11.6	26900	0.165	2170	3930
1-3			<4.82	19400	8.24	1130	0.586	5160	<0.56	24.3	12.4	30600	0.172	2290	3950
2-1	1.15	<0.60	<4.86	19200	13.6	1150	0.574	33700	7.10	17.6	81.5	26300	0.258	2710	9710
2-2			5.08	18900	13.7	926.0	0.564	31100	9.10	17.7	108	26800	0.253	2560	10000
2-3			6.94	18900	25.7	1030	0.480	31000	21.4	17.0	244	25600	0.375	2910	8610
3-1	1.23	<0.37	<4.97	25700	17.7	313.0	1.41	12700	<0.58	27.2	10.3	62700	0.165	1940	8960
3-2			<4.89	27700	7.22	324.0	1.11	12300	<0.58	29.8	11.3	44000	0.167	1710	9190
3-3			<4.88	26300	5.20	311.0	1.57	12800	<0.58	29.2	8.89	36800	0.165	1640	8460
4-1	1.09	<0.31	<4.91	27000	6.78	418.0	0.556	8980	<0.58	45.5	39.6	31000	0.155	1920	5760
4-2			<4.91	23900	8.65	391.0	0.498	9240	<0.57	68.2	41.6	37800	0.165	1990	6610
4-3			<4.85	21300	9.65	381.0	0.483	8940	<0.58	38.5	42.6	33400	0.174	1890	5510

* w/w Means mg/kg wet weight. All other concentrations in this table are given in dry weight for the portion passing a 0.150 mm sieve

APPENDIX III TABLE 1 SILVER TUSK SEDIMENT CHEMISTRY DATA, JUNE 10, 1981
(all concentrations given in mg/kg dry weight unless otherwise noted)

STATION	Mn	Mo	Na	Ni	P	Pb	**Sb	**Se	Si	Sn	Sr	Ti	V	Zn
1-1	594	<2.42	324	9.02	817	10.1	<0.830	<0.830	4130	<16.2	65.1	966	52.2	68.7
1-2	484	<2.44	286	8.12	747	9.82	<0.795	<0.795	4580	<16.2	60.4	908	50.4	66.7
1-3	690	<2.41	299	10.3	767	11.2	<0.800	0.800	4180	<16.1	69.0	955	53.1	73.6
2-1	779	<2.43	364	<6.48	1450	530	1.59	<0.820	4410	17.0	156	1300	67.3	992
2-2	784	<2.42	339	<6.44	1470	702	1.69	<0.810	4400	<16.1	142	1190	65.4	1230
2-3	912	<2.48	234	<6.61	1390	1340	3.46	<0.830	5090	<16.6	143	944	61.2	2590
3-1	1530	<2.48	354	<6.62	1970	<6.62	<0.830	<0.830	3930	50.5	110	2940	92.7	98.4
3-2	986	<2.45	369	<6.52	1700	9.52	<0.830	<0.830	4870	44.0	107	2600	86.1	103
3-3	767	<2.44	432	<6.50	1710	9.12	<0.825	<0.825	3990	68.4	108	3440	81.5	92.9
4-1	557	<2.46	418	22.5	1010	38.3	0.931	<0.825	5330	45.8	166	1530	70.8	138
4-2	1110	<2.45	405	32.8	1400	40.1	1.31	<0.830	4720	42.5	153	1630	85.0	165
4-3	914	<2.48	379	16.5	1340	51.0	2.11	<0.830	5450	35.5	149	1520	81.2	154

** The concentration of Sb and Se are included for information only since the analytical method has not been tested fully.

APPENDIX III TABLE 2 SILVER TUSK SEDIMENT PARTICLE SIZE ANALYSIS - JUNE 10, 1981

STATION NUMBER	PERCENT COMPOSITION				
	>500 um	250-500 um	149-250 um	62.5-149 um	<62.5 um
1-1	75.0	6.2	4.3	8.1	6.4
1-2	77.1	6.2	4.1	7.5	5.1
1-3	78.7	6.3	3.4	6.2	5.4
2-1	18.3	12.9	18.6	28.8	21.4
2-2	34.5	15.5	16.0	22.7	11.4
2-3	36.7	14.9	16.6	21.3	10.5
3-1	59.7	12.7	6.3	11.5	9.8
3-2	68.9	9.4	5.7	10.0	5.9
3-3	67.6	12.7	6.4	8.2	5.1
4-1	75.0	11.7	4.8	5.6	3.0
4-2	90.2	6.6	1.9	0.9	0.3
4-3	90.5	5.6	1.9	1.3	0.8

APPENDIX IV

BOTTOM FAUNA DATA

APPENDIX IV TABLE 1 BOTTOM FAUNA TAXONOMIC GROUPS FOUND IN THE SILVER TUSK WATERSHED
(Number 1, 2, 3, etc. are cross-referenced to date in Appendix IV, Table 2)

	Phylum:	Platyhelminthes
1.	Class:	Turbellaria
	Phylum:	Annelida
	Class:	Oligochaeta
	Order:	Haplotaxida
2.	Family:	Enchytraeidae
	Family:	Tubificidae
3.		Aulodrilus sp? immature
4.		Ilyodrilus templetoni
5.		Stylodrilus heringanus
	Phylum:	Arthropoda
	Class:	Insecta
	Order:	Plecoptera
	Family:	Nemouridae
6.		Podmosta sp.
	Family:	Capnildae
7.		Capnia sp.
	Order:	Ephemeroptera
	Family:	Baetidae
8.		Baetis sp.
9.		Ephemerella flavilinea
	Family:	Heptageniidae
10.		Epeorus sp.
	Order:	Trichoptera
	Family:	Rhyacophilidae
11.		Rhyacophila angelita
12.	Order:	Diptera adult
13.	Family:	Simuliidae
14.		Prosimullium sp. pupa

APPENDIX IV TABLE 1 BOTTOM FAUNA TAXONOMIC GROUPS FOUND IN THE SILVER TUSK WATERSHED (continued)

15.	Family:	Chironomidae pupae
16.	Subfamily:	Tanypodinae
17.		*Procladius* sp.
	Subfamily:	Diamesinae
18.		*Diamesa* sp.
	Subfamily:	Orthocladiinae
19.		*Cardiocladius* sp.
20.		*Corynoneura* sp.
21.		*Cricotopus* sp.
22.		*Epoicocladius* sp.
23.		*Eukiefferiella* sp.
24.		*Heterotanytarsus* sp?
25.		*Heterotrissocladius* sp.
26.		*Orthocladius* sp.
27.		*Psectrocladius* sp.
	Subfamily:	Chironominae
28.		*Micropsectra* sp.
	Family:	Empididae
29.		*Hemerodromia* sp.

APPENDIX IV TABLE 2 SILVER TUSK BOTTOM FAUNA DATA, JUNE 10, 1981

TAXONOMIC GROUP	STATION 1			STATION 4		
	1-1	1-2	1-3	4-1	4-2	4-3
1. Turbellaria	-	-	-	1	-	-
2. Enchytraeidae	-	-	-	-	1	1
3. Aulodrilus sp? imm	-	1	-	-	-	-
4. Ilyodrilus templetoni	-	1	3	-	-	-
5. Stylodrilus heringanus	2	1	1	-	-	-
6. Podmosta sp.	-	12	13	43	18	15
7. Capnia sp.	-	-	-	-	-	2
8. Baetis sp.	1	1	-	-	-	-
9. Ephemerella flavilinea	1	-	-	-	-	-
10. Epeorus sp.	1	-	-	-	-	-
11. Rhyacophila angelita	1	-	-	-	-	-
12. Diptera adult	-	-	-	-	1	-
13. Simuliidae	18	1	7	60	6	6
14. Prosimulium sp. pupa	-	-	1	-	-	-
15. Chironomidae pupae	1	-	1	-	-	-
16. Tanypodinae	1	-	-	-	1	-
17. Procladius sp.	1	-	-	-	-	-
18. Diamesa sp.	-	-	-	40	8	4
19. Cardiocladius sp.	-	-	-	6	-	2
20. Corynoneura sp.	-	-	-	1	-	-
21. Cricotopus sp.	3	2	3	12	4	1
22. Epoicocladius sp.	-	-	-	2	-	-
23. Eukiefferiella sp.	-	-	2	1	-	-
24. Heterotanytarsus sp?	-	-	-	-	3	2
25. Heterotrissocladius sp.	-	2	3	76	24	12
26. Orthocladius sp.	-	-	3	-	1	-
27. Psectrocladius sp.	-	1	1	-	1	-
28. Micropsectra sp.	-	-	1	-	-	-
29. Hemerodromia sp.	1	-	-	-	-	-
Column total	31	22	39	242	68	45
Total Number (N)	11	20	31	181	56	36
Diversity H'	0.86	0.59	0.82	0.63	0.58	0.61